

CENTRAL OFFICE EQUIPMENT SWITCH QUANTITIES  
(LARGE CENTRAL OFFICES)

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## 1. GENERAL

This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses the features and methods of engineering dial central office equipment for offices which are likely to exceed 1,000 lines ultimately.

- 1.01 This material is intended to provide information from which can be determined the proper types, quantities and grouping arrangement of terminal-per-station central office equipment for a dial installation. In general it is expected that these offices will be provided with all the features found in the smaller metropolitan areas.
- 1.02 It is assumed that the reader is familiar with Sections 325 and 510 of this manual and he should have had some experience in the engineering of small dial offices. The same basic methods are followed in the engineering of larger offices but many details and refinements are required for larger offices and the methods to be followed in arranging selector multiple trunking are considerably more involved.
- 1.03 There are several types of terminal-per-station dial equipment available for use of REA borrowers but it is not practical now to cover the detailed methods of engineering for all types. In this section the methods of engineering step-by-step equipment will be covered as they will also serve for the present as a guide in engineering other types of central office equipment. Other types of equipment can provide the same service features as are covered in this section. However, the methods required to determine the quantities and arrangements of equipment will be different.
- 1.04 It is essential that reliable basic traffic data be used in the design of an office so that the proper amount and arrangement of the equipment can be provided. In an existing dial office traffic data in the form of switch counts or plug counts for the busy hour of the busy season should be taken in sufficient quantity to insure that reliable information is available for engineering. These switch counts can be made manually, but more reliable data can be obtained with a machine trunk usage

recorder as outlined in Section 515. The use of the calling rate information from the table in Section 515 for unit calls per main station should not be used to develop traffic data for the larger offices. More reliable data for the particular office to be engineered should be available or obtained. The use of inaccurate or inadequate traffic data may result in the provision of an excessive amount of equipment or an insufficient amount which will result in poor service. Also poor service can result from the provision of adequate equipment if it is not properly arranged.

- 1.05 The various traffic capacity tables in this section are intended for use in engineering trunk groups in terminal-per-station offices as covered in this section and they are not intended for use in the terminal-per-line offices as covered in Section 510.
- 1.06 As an aid to the reader in understanding the material covered by this section, an example has been prepared showing the arrangement of traffic data, the calculation of switch quantities and the use of traffic capacity tables in arranging selector multiple trunking for an office of 2,400 terminals. The example is covered in Appendices 1, 2 and 3.

## 2. LINEFINDERS

- 2.01 General - Linefinders function to connect a large number of lines to a small number of first selectors. Each linefinder is directly connected to a first selector. The traffic originated by 100 subscriber lines in a group will usually require from 10 to 14 linefinders and an equal number of first selectors. A group of 200 lines will usually require from 15 to 20 linefinders and the same number of first selectors. The actual number to be provided with either size group will vary with the busy hour calling rate in unit calls per line.
- 2.02 Segregation by Classes of Service - Separate groups of linefinders may be required in an office for different classes of service but, under conditions found in REA borrowers' systems, segregation of groups is not usually required. It is possible to serve flat rate, rural and post-pay coin lines without providing segregated groups for any one of the three classes. Pre-pay coin lines

may be operated in either separate linefinder groups or in specially arranged combined groups with flat rate lines. Equipment for pre-pay coin is more expensive than that required for classes of non-coin service or for post-pay coin.

2.03 Flat Rate Line groups - A majority or all of the linefinder groups in an office will be arranged to serve flat rate lines. Rural lines can be served in the same line groups with other classes of flat rate service. Should the line lockout feature be required, one of the several arrangements described under "Lines Requiring Lockout Feature" can be used.

2.04 Post-Pay Coin Lines - Post-pay coin lines are generally assigned in the same linefinder groups with the flat rate lines and need not be segregated on the connectors when the thousand group for coin numbers is not equipped. Under these conditions, it is preferable in most cases to assign coin lines to terminals in the rotary connector groups. However, when the thousand group, usually 9000, for coin is equipped instead of being multiplied to another thousand group, then the coin numbers should be assigned to a definite consecutive series.

2.05 Lines Requiring the Lockout Feature - When a permanent signal condition, trouble or telephone off the hook, occurs on a line it is desirable to release the linefinder and first selector promptly. This is accomplished by adding special equipment in the line circuit (line lockout) and a timing circuit in the first selector so that when a permanent occurs the timing circuit functions to time out in a brief period after which the line is held by the line circuit. This operation of the line circuit frees the linefinder and first selector for service to other lines in the group of linefinders. The lockout feature is not ordinarily required in offices having a maintenance man in attendance for most of the day hours. Equipping all lines for lockout may be justified in small unattended offices having 200 to 400 lines with a high rural development. Equipping only a percentage of the lines, about 10 percent, will be found

satisfactory for the rural lines in larger offices where a maintenance man is not in attendance. The line lockout feature can be provided with several different arrangements of equipment. One of the following arrangements will take care of most conditions requiring line lockout:

- (a) Equip all lines in the office for line lockout.
- (b) Equip a percentage of the lines in each linefinder group for line lockout.
- (c) Provide line adapters for the number of lines requiring line lockout and these adapters are cross-connected to the lines requiring this feature in any linefinder group.
- (d) Provide separate linefinder groups for the rural lines and any others requiring the lockout feature. All line circuits in these segregated groups are equipped for lockout.

Under (b) and (c) it is assumed that each linefinder group will have approximately the same number of lines assigned with the lockout feature and this requires that all first selectors be equipped for timing of permanents. All first selectors must also be equipped for timing under (a). Only the first selectors for the line groups arranged for lockout, (d), require the timing feature. In the latter case, these first selectors are assigned as evenly as possible over all first selector shelves among those serving the regular linefinder groups.

2.06 Pre-Pay Coin Lines - Special equipment must be provided for pre-pay coin service either in the line circuit or as a trunk circuit between the linefinder, or line switch; and first selector. The arrangement usually provided depends on the number of coin lines in the office and in general one of the following plans will meet the requirements for coin service:

- (a) For ten lines or less provide an adapter for each line and a first selector is required for each line.
- (b) For 11 to 50 lines a combination linefinder group is provided for coin and flat rate lines. A number of coin trunk circuits, adequate to handle the traffic from coin lines, is provided between the linefinders and the first selectors for the group. The trunk circuits are switched into the connection only on calls from coin lines.

(c) When an office has more than 50 coin lines, a line group or groups is provided, similar to that used for flat rate lines except that a coin trunk circuit is required between each linefinder and its first selector.

2.07 Engineering Linefinder Groups - Linefinder groups having a capacity for 200 lines have two (one per hundred) of the line circuits arranged for test purposes which leaves 198 that can be used to terminate subscriber lines.

2.071 The linefinder groups of 100 lines capacity are arranged in a similar manner to the 200 line groups and the subscriber line capacity is reduced by one for the test terminal.

2.072 To determine the number of linefinders required per group for any class of service, assuming 200 line capacity groups are to be used, the estimated busy hour unit calls per line is multiplied by 198. This product is the total unit call load per group which is read into the "Linefinder Capacity Table", Figure 2. This 1.5 percent dial tone table is approximately equivalent to Table 20 ( $P = .02$ ). If the estimated traffic load is realized during the busy hour of the last busy season of the engineering period about 1.5 percent of the originating calls will encounter a three or more seconds delay in receiving dial tone. See sample traffic calculations for the Diamond (342) office in Appendix 2.

2.073 In the case of 100 line capacity linefinders the same procedure is followed, 99 lines is multiplied by the estimated unit calls per line and the product is read into the same column of the table referred to above.

### 3. SELECTORS

#### 3.01 General

3.011 Selectors are connected in the switching train between the linefinders and connectors in an office and they function to make trunk selection as the digits of the called number are dialed. The last two digits dialed are generally used in the connector to make connection to the called station. An office

can have from one to five stages of selectors although generally in the REA borrowers' systems there will be only two stages, first and second selectors. In small offices only one stage, first selectors, may be required. When a seven digit number (2 letters and 5 numerals) is dialed the first selector will absorb the first three digits in many cases and then select an idle trunk to second selectors when the fourth digit is dialed. The second selector in the train will receive the fifth digit and select an idle trunk to a connector.

3.012 As discussed in TE & CM Section 208 customers may not be required to dial all seven digits of the listed number on intraoffice calls, although the equipment is generally arranged so that calls will be completed if the entire seven digit directory number is dialed. Usually customers will be instructed to dial the last 4 or 5 digits of the directory number on calls to stations served by their own office. It is expected that on all calls to EAS offices the customers will be instructed to dial the seven digit directory number.

3.013 An office having first and second selectors, two stages of selectors, will normally have a capacity for 8000 terminals or 1000 terminals from each of the first selector levels 2 to 9. For each 1000 terminals a group of second selectors is required. Each first selector level used for a trunk group, such as for EAS trunks, will reduce the capacity of the office by 1000 terminals. However, it is expected that some offices will have less than 1000 terminals and some of the connector groups will be assigned directly to first selector levels with the first four digits absorbed by the first selector. As an example, an office with 1000 terminals, as many as seven connector groups can be assigned to first selector levels and the remaining three groups would be served from a group of second selectors. The seven connector groups will be reduced by one for each trunk group, such as for EAS trunks assigned to a first selector level. The hunting connector group should ordinarily be one of the groups assigned to a first selector level.

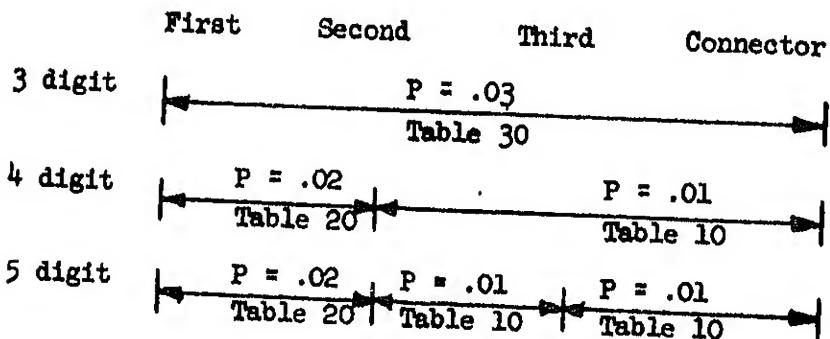
Note: See TE & CM Section 208 for information on making provision for growth when assigning first selector levels and note the example for a case similar to the one described above.

3.014 One first selector is provided for each linefinder and one for each incoming or two-way trunk from other offices and from operators.

3.02 Engineering Service Bases

3.021 The overall grade of service after receipt of dial tone as engineered for a step-by-step type office is generally represented by the sum of all the delays used in engineering the trunks from the different selector stages. The delays (tables) used in providing trunks in a 4-digit trunking system should be different, less liberal, than those used in a 7-digit trunking system in order that the overall service results obtained in each office be comparable. Experience has indicated that this attempt to make the overall grade of service comparable and at the same time satisfactory to the user in the different sized systems, can be obtained by using the following tables for engineering selector multiple trunks.

Selectors



3.022 It will be noted that the number of effective digits is used to determine whether a system is a 3, 4, or 5-digit system when operated on a terminal-per-station basis. REA borrowers' systems covered by this section will have 7-digit directory numbers but it is expected that a high percentage of these offices will use three or four effective digits on intraoffice calls.

3.023 Table 10 ( $P = .01$ ) is used for trunks to service code selectors and for any trunk groups to and from switchboards and desks located in the same building with the dial equipment. The basis for providing trunk groups (11X) from the service code selector levels is covered later under Service Code Selectors.

3.024 The provision of interoffice trunks should be on the same basis as for the smaller offices as outlined in Section 510.

3.025 A copy of each of the traffic capacity tables required to engineer trunks from selector levels covered in this section, are attached as Figures 3 to 7.

### 3.03 Segregation of Selectors by Classes

3.031 The subscriber first selectors in an office may be segregated by classes to agree with the segregation by classes at the linefinders. This segregation may be required for circuit or equipment reasons or it may be necessary to provide a separate multiple of trunks from first selectors to operators. A separate trunk group to operators may be required with some arrangements for handling prepay coin traffic.

3.032 The linefinder groups serving the different classes will vary in size and the associated first selectors will, therefore, operate at different efficiencies. This, in most cases results in each segregated class of first selectors having a different calling rate per selector when the out trunking from first selectors is being determined. However, in most REA borrowers' offices subscriber first selectors will not be segregated except possibly where there is an appreciable development of prepay coin. As described previously in paragraph 2.05 where separate linefinder groups are provided for rural lines the associated first selectors will be spread evenly over all first selector shelves.

3.033 Incoming trunk selectors from EAS offices, toll, etc., will be mounted on separate shelves from the subscriber first selectors. If the incoming trunks do not all have the same access they can

be mounted on separate shelves as necessary to provide the required selector multiple arrangement. Segregation may not be necessary to deny access to certain levels if the selectors are equipped for digit absorbing. The use of digit absorbing selectors for this purpose may be especially attractive where only a few selectors are involved.

3.04 Arrangement of Trunks from Selector Levels

3.041 The design of dial equipment available for use of REA borrowers' employ several types of switches to do the trunking within an office and to outgoing interoffice trunks. The maximum access of the switches varies from 12 to 20 or more trunks as compared to the step-by-step selector. The step-by-step selector has access to not more than ten trunks on each of its ten levels and the ten selectors on a shelf have a common bank multiple for outgoing trunks. Therefore, the ten selectors on the same shelf will use the ten or less working trunks of any one of the ten levels in common. While the access from a shelf of selectors is limited to a group of not more than ten trunks for each level, two or more shelves can be combined so as to form a trunking arrangement known as graded multiple with 11 or more trunks. See TE & CM Section 510 for an explanation of graded multiple.

3.042 Trunks to Connector Groups

3.0421 The trunks to connector groups are generally provided in one group for the 100 terminals. Except for trunk groups to rotary and level hunting connectors the use of graded multiple trunking will rarely be required as other connector groups will usually have ten or less trunks per group. The selector shelves preceding connectors may be an odd number and often some of the shelves will have less than ten selectors. Under these conditions any graded multiple groups to connectors may have some traffic unbalance and certain of the earlier choice individual trunks may not receive the proper proportion of the load. The "Connector Capacity

Tables", Figure 2, make allowance for the lower overall efficiency of graded groups to connectors. The detailed methods to be followed in providing connectors are covered later under "Connectors."

### 3.043 Outgoing Inter-office Trunks (1 or 2-way)

Each of the trunk groups from selector levels to the operator office and to EAS offices will generally be arranged in one group as they will seldom be large enough to require subgrouping. When a group requires ten or less trunks all the number to be provided can be determined by using the estimated traffic with the proper traffic capacity table in TE & CM Section 510.

3.0431 The procedure to be followed if more than ten trunks are required will be the same as was outlined above for the smaller groups except that graded multiple must be used. After the number of trunks has been determined the arrangement of the selectors, usually subscriber first selectors, for the graded trunk group must be determined. The basic grading pattern to be used is controlled by the number of selectors and the number of trunks. Using Figure 1 the column for the "Selectors per Subgroup" closest to the number of selectors for the group being engineered should be selected. The pattern for the grading is then selected for the number of trunks previously determined. This pattern may have to be modified to get an efficient arrangement to meet the requirements, unless the number of selectors coincides exactly with the number as selected from the charts.

3.0432 A simple case will be used to explain the procedure described above. Assume an office with 40 subscriber first selectors require 17 trunks to an EAS office. Refer to Figure 1, Page 1, and in the second column (40 selectors per subgroup) will be found the pattern to be used for 17 trunks. To illustrate a case requiring

some modification of the grading pattern, assume an office with 36 selectors, mounted 10 on shelves 1, 2 and 3 and 6 on the last shelf with 21 trunks. The traffic for the group is 450 unit calls. Again on the same chart for 40 selectors (nearest subgrouping to 36) use the grading pattern for 21. The unit calls delivered to the group by each selector is  $450 \div 36 = 12.5$  U.C. or a shelf of ten selectors delivers 125 U.C. and shelf of 6, 75 U.C.

<u>Shelf</u>	<u>No. Sel.</u>	<u>No. U.C.</u>	<u>% Of Total U.C.</u>	<u>Theoretical No. Indiv. Trks.</u>	<u>Grading Pattern</u>
1	10	125	27.8	(4.4)	....
2	10	125	27.8	(4.4)	....
3	10	125	27.8	(4.4)	..
4	6	75	16.6	(2.7)	.

In any grade there should be a minimum of five common trunks. In the grade for 21 trunks there are 16 individual trunks (other than commons) and applying the above percentages there should be 9 individual trunks for the first two shelves and 7 for the two lower shelves. The modified grade to meet these requirements is shown above.

3.0433 Trunk groups for 11 to 25 or 30 trunks for two-way service can be arranged in a form of graded multiple by providing some individual one-way trunks from each office as first choice and a group of two-way common trunks. Usually approximately half of the individual trunks in the graded group are outgoing from each office and at least five common trunks should be provided for the two-way trunks. The individual trunks at each office can be arranged in one or more legs depending on the total number of trunks required between the two offices. This trunking plan is discussed in Section 510 of the TE & CM.

3.044 Trunks to Selectors: The trunks to selectors, usually second selectors, will ordinarily be arranged in one combined group for the subscriber first selectors and all incoming selectors to as many as 37 trunks to selectors. This allows for some growth (to 45 trunks) before a radical change in the grading pattern is required. If more than 37 trunks to selectors are required for a level, one subgroup of trunks for over half of the subscriber first selectors should be provided and the remaining selectors (subscriber first and incoming) should be arranged as a combined subgroup with a second group of trunks to selectors.

3.0441 Levels Requiring 37 or Less Trunks: The procedure for arranging a combined group of trunks from a first selector level to second selectors is to determine the grade of service and how the selectors are mounted on shelves and then from the traffic estimates determine the unit calls delivered by each shelf. For the total shelves of selectors, say 12, select from Figures 3 to 7, as required, the "Selector per Subgroup" closest to the shelf capacity of the first selectors, 120 in this case. Assuming a grade of service of  $P = .02$ , the column for 120 selectors in Figure 5 should be used to determine the number of trunks to second selectors to be provided based on the estimated traffic. The grading pattern must then be modified to properly handle the traffic to be delivered by the various selector shelves.

3.04411 A simple case will be used to explain the above-mentioned method. Assume an office with 36 subscriber first selectors, six incoming EAS selectors and seven incoming toll selectors. The total traffic estimated for a level to second selectors amounts to 408 unit calls. The desired grade of service is  $P = .02$ . There will be six shelves with a total capacity for 60 selectors.

Therefore, the pattern to be used will be one for the 60 selector subgrouping and from the table, Figure 5, under the 60 selector column, 408 unit calls will require 20 trunks to second selectors. The distribution of traffic by shelves is as follows:

In any grade there should be a minimum of five common trunks. In the standard grade for 60 selectors on 20 trunks there are 15 individual trunks (other than common). After applying the above percentages, ten individuals are required for the first three shelves. The remaining 5 are required for the last three shelves. The modified grading pattern to meet the requirements is shown above. See Appendix 2, multiple for first selector level 4 as another example.

**3.0442 Levels Requiring More Than 37 Trunks:** When the volume of traffic to a group of second selectors is sufficient to require more than 37 trunks, the trunks should be arranged in

two subgroups. The first subgroup should be designed to remain the same as additions are made to the office so that rearrangements can be confined to the second subgroup. However, should the traffic delivered by the selectors in the first subgroup change at any time, the number of trunks for the subgroup can be increased or decreased as required. The subscriber first selectors will usually originate the greater part of the traffic to a group of second selectors and the first subgroup should be made up from these selectors.

3.04421 The method to be used in arranging this first subgroup is to determine the calling rate per subscriber first selector by dividing the total estimated traffic to be delivered to the level by these selectors by the number of selectors. By referring to the table, Figure 5, (for second selectors,  $P = .02$ ) select a suitable subgrouping by applying the calling rate per selector to the proper column. From this table can be determined the number of selectors for the subgroup and the number of trunks required. In selecting the subgrouping to use, one should be specified which will result in providing for the first subgroup slightly over half of the total trunks to the second selectors. However, the first subgroup should not be too large as the second subgroup should, if possible, have more than 11 to 15 trunks.

3.04422 The above-mentioned method is used in the following example for traffic to a group of second selectors:

	<u>First</u> <u>Selector</u>	<u>Unit</u> <u>Calls</u>
Subscriber	102	733
EAS	20	111
Toll	13	94
		<hr/>
Total		938

Calling rate per subscriber first selector  $733 + 102 = 7.19$ .

From the table, Figure 5, it is possible to use one of four subgroupings with the 7.19 calling rate; 100 selectors on 35 trunks, 80 selectors on 29 trunks, 60 selectors on 21 trunks or 40 selectors on 15 trunks. Since 80 selectors will deliver 575 unit calls and require over half of the total trunks to second selectors this subgrouping will be used. The remaining 22 subscriber first selectors will deliver 158 unit calls ( $22 \times 7.19$ ) and this traffic will be combined with that from EAS and toll selectors for a total of 363 U.C. for the second group. This combined subgrouping will be treated in the same manner as was described previously (paragraph 3.04411) for combined groups of 37 or less trunks. These selectors shelves will be considered as equivalent to

six (60 selector subgrouping) in selecting a grading pattern with 19 trunks. The modified grading pattern was determined as follows:

<u>Class Sels.</u>	<u>Shelf</u>	<u>No. Sels.</u>	<u>U.C.</u>	<u>% Of Total U.C.</u>	<u>Theoretical No. Indiv. Tks.</u>	<u>Grading Pattern</u>
Subscriber	9	10	72	19.9	2.8	.
Subscriber	10	10	72	19.9	2.8	.
Subscriber	11	2	14	3.8	.5	
Toll	12	3	22	6.1	.8	
Toll	13	10	72	19.9	2.8	
EAS	14	10	56	15.2	2.1	
EAS	15	10	55	15.2	2.1	

In the standard grade for 60 selectors on 19 trunks there are 5 common and 14 individual trunks. After computing the theoretical number of individual trunks per shelf the standard grading pattern (Figure 1) was modified accordingly. Note also that there is approximately an equal amount of traffic being offered each side of the reversal in the common trunks. This illustration is for level 2 of the example, Appendix 2.

### 3.05 Service Code Selectors

3.051 For small offices, special services such as information or repair are generally provided by dialing "0" or by dialing subscriber lines designated for these purposes in the directory. In larger offices the amount of this traffic may justify the provision of separate trunk groups for some or all classes of this traffic. When separate trunk groups are to be provided, it is customary to establish a group of service code selectors assigned to level 1 of the subscriber first selector. In addition to routing calls to the various 11X trunk groups the service code selectors receive calls preceded by a preliminary pulse. These selectors are arranged to

absorb the digit 1 (Function A) and refuse to cut through (Function B) on levels 2 to 0 except in response to a digit following a "one." It should be noted that the blocking feature is used on vacant levels which is an exception to the general rule. This treatment is used in this case on account of preliminary pulse calls.

3.052 The number of service code selectors is determined from the sum of the estimated traffic to be routed from the various levels of these selectors. To this code traffic should be added for (preliminary pulses) one fifth of one percent of the total traffic used to engineer the linefinders. The "Trunk Capacity Tables", or "Selector Multiple Tables" are used to determine the number of service code trunks as follows:

<u>Level</u>	<u>Code</u>	<u>To</u>	<u>Basis</u>	
			<u>Within Building</u>	<u>Outside Building</u>
9	119	Reverting Call Selectors	Table 10	--
8	118	Dial & Ringer Test	*	--
7	117	Test Desk	*	--
4	114	Repair Service	*	--
3	113	Information	Table 10	**
2	112	Reserved for Direct Distance Dialing Trunks		

\* Determined by local conditions.

\*\* See TE & CM Section 510

3.053 In addition to the 11X code trunk groups mentioned in the above table, other groups may be required initially or later. The use of the code 112 may be required ultimately for routing customer dialed toll calls to the National Network.

#### 4. CONNECTORS

4.01 General - Connectors serve to select and connect to the called party's line, provide the proper ringing signal, return an audible ringing signal to the calling party if the line is not busy and if the called line is busy return the line busy signal. Each connector is arranged to provide either a one or two ringing code of any five frequencies on each terminal so that any station on a line can be assigned to any terminal. Each group of connectors ordinarily has access to 100 terminals and each terminal

has access to one main station or PBX trunk. Each connector group is reached from a level of the selectors preceding the connectors.

4.02 Segregation by Types of Connector Groups

4.021 Regular

4.0211 The nonhunting connectors are arranged to select the one terminal as dialed by the calling party and if that line is busy the connector will return the line busy signal. They serve all classes of lines except those groups of two or more lines (or trunks) where an idle line in the group must be selected in response to calls dialed to the directory number, as is required for PBX trunk groups and associated lines. Obviously a high percentage of the connector groups in an office will be of the non-hunting type which are generally known as regular connector groups.

4.0212 Coin stations are segregated in separate thousand number series for operator identification purposes as discussed later under "Assignment of Groups."

4.022 Rotary Hunting

4.0221 Rotary hunting connectors are used to serve associated lines, groups of individual lines having consecutive numbered terminals, and PBX trunk groups which are not large enough to justify level hunting connectors. Stations usually assigned to regular groups may also be served in rotary hunting groups. It is desirable to assign initially to rotary groups any lines normally operated in regular groups which are likely to become one of an associated group or may convert to PBX service. In smaller offices where it is necessary to provide a rotary hunting connector group or groups for a small number of associated lines

4.032 There is one exception to the spreading of the different classes of connector groups over the various thousands. Coin lines, postpay or prepay, must be grouped in certain thousands in order that toll operators may recognize coin station numbers so that calls to these numbers may be handled properly. The preferred thousand for coin station numbers, and the one quite generally used, is in the 9000 series. Should it be impractical to use this series in some special case, the 8000 or 7000 series can be used. It is not necessary that these thousands be equipped as the selector level corresponding to the 9, 8 or 7 can be multiplied to some other working level of the selector. The coin numbers for an office will ordinarily require less than 100 terminals and other classes of service can be assigned terminals in the coin connector group.

4.033 When the 9th (8th or 7th) level is multiplied to a lower equipped level of the selector to provide for coin numbering the coin lines need not be segregated in a consecutive series of numbers but can be assigned in several different hundreds within the thousand group. In this connection there is an advantage in having the coin stations assigned to terminals likely to be needed for growth in the number of trunks to PBXs. When these terminals are required, the coin numbers can be reassigned since changing these numbers is not considered particularly objectionable. However, if the 9th level is equipped, it is expected to be equipped within a few years, it would be preferable to have the coin lines assigned within a definite series of numbers. Should there be 60 to 80 or more coin lines separate consecutive hundreds as required should be reserved for coin numbers only.

4.04 Number of Connector Terminals Required

4.041 Offices as covered in this section are to be operated on a terminal-per-station (TPS) basis for all lines including rural. The terminal-per-station connector has one set of terminals for each main station, including PBX trunks. Extension stations including stations served from a PBX do not require the use of a terminal.

4.042 An estimate should be prepared of the working connector terminals by classes as they will be segregated by connector groups; that is, PBX and associated lines, coin, regular and others as required. To the working terminals as determined must be added the following:

1. Extra terminals to cover numbers which cannot be reassigned immediately, such as number changes and disconnects in order to provide an adequate intercepting service to meet the requirements of direct distance dialing. Reasonable extra terminals in the hunting groups to care for growth in size of PBX trunk groups.
2. Provision should be made for listing PBX numbers to be called at night.
3. Extra terminals will be required for alarm checking if alarm signals are extended to another office.
4. Terminals required for test purposes - 1 per hundred for regular groups, 2 per hundred for rotary groups and 3 per hundred for level hunting groups.

4.043 Connector terminals are provided in units of 100. The equipped terminals required for each class will be the working terminals plus the extra terminals under 1, 2, 3 and 4 plus any spare terminals required, including those for PBX growth. The number of extra terminals to be provided under 1 above must be based on local conditions at the office being engineered, giving particular consideration to the frequency of directory issues. Development of the connector terminal requirements is illustrated in the example, Appendix 1.

#### 4.05 Traffic Per Connector Group

In distributing the traffic to connector groups it is assumed that the terminals will be assigned to the different groups so that the volume of traffic offered each group within a class (regular, coin, trunk hunting, etc.) will be approximately equal. It is, therefore, the general practice to provide the same number of connectors for each group within each class. When the traffic is distributed to all the groups in this manner the total traffic to all groups in the office should check with the total intra-office and incoming unit calls.

#### 4.06 Number of Connectors Per Group

The number of connectors per group is determined by referring to the connector capacity table, Table 10, Figure 2, for connector groups assigned to second selector levels. For groups assigned to first selector levels Table 30, Figure 2, should be used. The number of connectors required is read from the column at left for the estimated unit call load in the proper column at right. See example in Appendix 2.

### 5. MISCELLANEOUS

#### 5.01 Concentrating Switches for Large Out Trunk Groups

5.011 Where a large volume of traffic is to be trunked to another office the use of concentrating switches in the originating office at the terminating end of the selector multiple trunks may be justified in order to operate the interoffice trunks in one large efficient group. This equipment will not usually prove economical in REA borrowers' systems where interoffice trunks are usually provided on a delay basis from  $P = .03$  to  $P = .10$ . However, the use of concentrating switches might be considered for trunk groups should they be provided on the basis of  $P = .01$  or  $P = .02$  if they are to have 40 or more trunks.

#### 5.02 Intercepting Arrangements

5.021 Intercepting lines are provided from connector groups and vacant terminals are connected to these lines. The total of the several types of intercepting lines required for an office of 5000 terminals will amount to approximately 60. The intercepting lines can be terminated at a switchboard located in the same building with the dial equipment or they can be terminated on concentrating switches from which a relatively small number of trunks terminate at a distant switchboard or desk. With the latter plan for unattended installations, use can be made of the operator group of trunks by giving the intercepting trunks access to the operator group. When an intercepting trunk is connected, a momentary distinctive tone is put on the operator office trunk so that operators can recognize the type of call.

5.022 On account of the number of intercepting lines required, it may prove economical or desirable for very large offices, requiring 50 or more intercepting lines, with a switchboard in the same building to provide concentrating equipment to reduce the number of trunks to be terminated at the switchboard. This will reduce the jack space required at the switchboard and will provide a more flexible plan as the intercepting trunks can be multiplied at the switchboard as desired.

5.023 Number of Intercepting Line Circuits - The number of intercepting line circuits required for an office can be determined as follows:

- (a) Intercepting lines from connector terminals -- one for each 100 terminals for regular connector groups and two for each hunting connector group.
- (b) Trouble intercepting lines -- one per 1000 terminals with a minimum of two. (Used only for lines out-of-order).
- (c) Vacant selector level -- two.

5.024 Concentrating Equipment

5.0241 The number of intercepting lines to be terminated on the concentrating switches is determined as outlined above.

5.0242 When the intercepting lines are to be concentrated the number of intercepting trunk circuits required can be determined for an office with normal traffic conditions from the following:

<u>No. of Intercepting Trunk Circuits</u>	<u>No. Connector Terminals</u>
1	400 or less
2	401 to 1500
3	1501 to 3000
4	3001 to 5000
5	5001 to 8000

5.029 Recorded Announcement for Intercepting Calls: In some cases the use of a recorded announcement system may be attractive as compared with trunking facilities for routing intercepted calls to an operator at a distant office. Vacant selector levels, unassigned, disconnected and changed numbers may be connected through suitable circuits to the announcement equipment. Changed numbers and recent disconnects may also be routed to an operator who can furnish the calling party with helpful information. Arrangements can be had to give one announcement (from one recording) on all calls or at a greater cost two or more different announcements can be provided so as to give more accurate information on the intercepted calls of the different classes.

5.03 Revertive Call Arrangements

5.031 Revertive calls are those made from one station to another on the same party line and special equipment or circuits are required for the completion of these calls. The several manufacturers of step-by-step equipment have different arrangements for handling revertive calls. A brief discussion of the method of operation for three plans is as follows:

- a. Calling party dials the directory number and when the line is reached by the connector, a special tone is received by the calling party to indicate that the call is to another station on his line. The calling party is instructed to hang up while the called station is being rung and then he returns to the connection to start conversation. The ringing is tripped when either station comes in on the line.
- b. Calling party dials the directory number as above and after the special tone is received, he is instructed to dial his specially assigned revertive digit appearing on his number plate. When he hangs up after dialing his revertive digit, the equipment proceeds to ring both stations. When ringing is tripped by the answer of the called station, the calling party returns to the connection to start conversation.

- c. Each customer is furnished a list of other parties on his line and for each, a special number is given to be dialed when making revertive calls. To complete a revertive call, a special code of two or three digits is dialed to reach the revertive call switches or circuits and then the special number, after which he hangs up. The equipment proceeds to ring both stations. When ringing is tripped by the answer of the called station, the calling party returns to the connection to start conversation.

5.032 When revertive calls are completed according to the first two methods above, the necessary equipment or circuits required is contained in the regular switching equipment used for the completion of other calls. With the last method a code must be assigned to reach the revertive call switches or circuits.

5.033 In small offices a level, other than level 1, 0, or 9 may be available on the first selector to which can be assigned the trunks to revertive switches. If the office is large enough to have second selectors it is preferable to assign a level on these selectors for reverting. However, when an office is provided with service code selectors, it is customary to assign the 9th level (code 119) of these selectors to trunks for revertive switches.

5.034 Calls on lines in an office having all lines in certain linefinder groups equipped with the lockout feature will hold the revertive call equipment only during the time a call is being established and when both parties have answered, the revertive call equipment is released and the line lockout holds the line during conversation. Revertive calls on lines not equipped with the lockout feature hold the revertive equipment after the revertive code is dialed until the hang-up after conversation.

5.035 Where an office is equipped for 100 percent lockout, the time that the revertive call switch is in use is only until the called station answers; where some of the lines in the group are not equipped for line lockout, it is necessary that the revertive call switch be held during the entire conversation time.

5.036 In an existing office where the method of operation is not to be changed, the traffic to be used to estimate the number of revertive call switches required should be based on switch counts, should an overflow meter not be associated with the trunk group. If a peg count meter is associated with the revertive switch group, an estimate of the holding time applied to the busy hour busy season peg count calls can be used to develop the revertive call unit calls.

5.037 The number of revertive call switches or circuits required for an office is determined by using the estimated busy hour busy season estimated traffic and Table 10 of the Trunk Capacity Tables, Figure 4.

5.04 Traffic Registers

5.041 Traffic registers of the different types are provided to record traffic data which is used to administer the various trunking paths in an office and to engineer changes in and additions to the equipment. All registers of the "all-trunks-busy" type are to be arranged to register every 6 seconds during an all trunks busy condition. The register equipment is provided as outlined in the following paragraphs:

Linefinders. One "all linefinders busy" or overflow register per group.

Intercepting Concentrating Trunk Circuits. One "all trunks busy" or overflow register per group.

Connectors. One pegcount register for each group. One all trunks busy, overflow or last trunk busy for each nongraded subgroup of trunks to connectors. For graded trunk subgroups one overflow or last trunk busy register for each subgroup.

Interoffice Trunks. One all trunks busy register for each nongraded subgroup. For one-way graded subgroups, one overflow or last trunk busy register per subgroup. For two-way graded subgroups, one last trunk busy register per subgroup.

Trunks to Local Second Selectors. One overflow or last trunk busy register per subgroup.

Revertive Call Switches. One all trunks busy, overflow or last trunk busy register per subgroup.

5.042 All traffic registers should be provided at one location in the switch room in space three feet from the floor to not more than five feet from the floor so they will be convenient for reading.

5.043 A battery cut-off key should be associated with the connector pegcount registers so they can be made inoperative when readings are not being taken. This key should be located adjacent to the registers and should be properly designated.

5.05 Test and Verification Distributors

5.051 Separate access is provided to connect terminals for test purposes from the test board and for verifying busy and don't answer conditions by operators. The test distributor and verifying distributor have 100 terminals and can have access to as many as 100 connector groups or a full office of 10,000 terminals. Each test connector, one is provided for each connector group, is connected to a terminal on the banks of the distributors. To make a test or a verification call, the last four digits of the number are dialed into the distributor, the first two digits are effective in the distributor and the last two in the test connector.

5.052 When the operator's switchboard is located in the same building with the central office equipment, direct trunks to the verifying distributors are provided from the switchboard.

5.053 When the switchboard is located in a distant building, one of several plans can be used by the operators to get access to the verifying distributors.

5.0531 In large offices provide separate trunks terminating directly in verifying distributors. In rare instances can this plan be justified.

5.0532 When the operator trunks are not accessible to customers when dialing EAS or toll calls into the office, the incoming selector from the operator office can have trunks

to the verifying distributors multiplied to one of its levels. Usually level 0 is used for this purpose. To verify a number, the operator must dial a prefix digit and then the last four digits.

5.0533 Many of the dial offices installed on REA projects are provided with one toll trunk group, which is used by the operator and will also ultimately be used for direct distance dialing by customers of incoming calls to the office. Since operator verification of busies and the ability to override a busy line for certain types of emergency calls are essential services, it becomes necessary to exclude customer access to the verification feature and one of the following plans can be used:

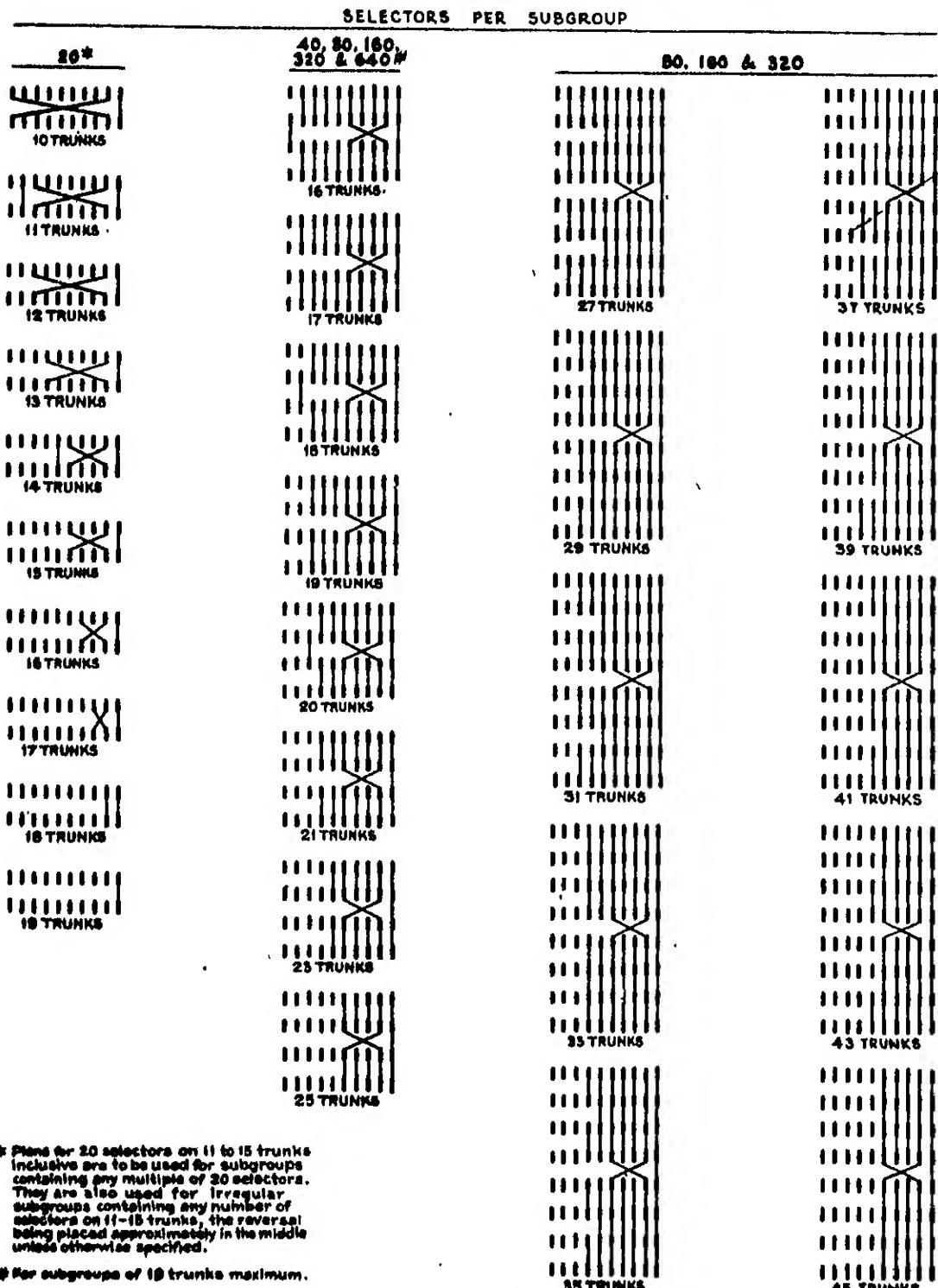
- a. When there are five or more trunks in a tributary group, one trunk may be assigned for operator use only at the toll center and, this would be the only trunk given access to the test distributor. This trunk should be first choice for outgoing calls at the tributary and first choice for the operators at the board. It is designated to show that it can be used for verification.
- b. For groups of four or less trunks, only the last choice trunk for incoming customer dialing calls may be arranged for access to the test distributor. It would be so designated on the switchboard and again would be the first choice for operators. Under this plan, incoming calls dialed by customers would hunt over the entire trunk group and if the last choice trunk is the only one idle, users could get access to a test connector, if they knew the code, but it could not well be done deliberately as most calls would go over the trunks with no such access.

c. The company operating the toll center may request use of the code "00" for reaching the verification selector in the dial tributary office and this will prevent customer access provided the call originates at or switches through a common control dial system. It is of no value where the dial system is of the "direct control type."

5.054 One test distributor is provided for each position of test board and one verification distributor is provided for each 2,500 terminals or less.



**GRADED MULTIPLE ARRANGEMENTS  
FOR TRUNKS FROM SELECTOR MULTIPLE  
TO OTHER SELECTORS, TRUNKS OR REPEATERS**

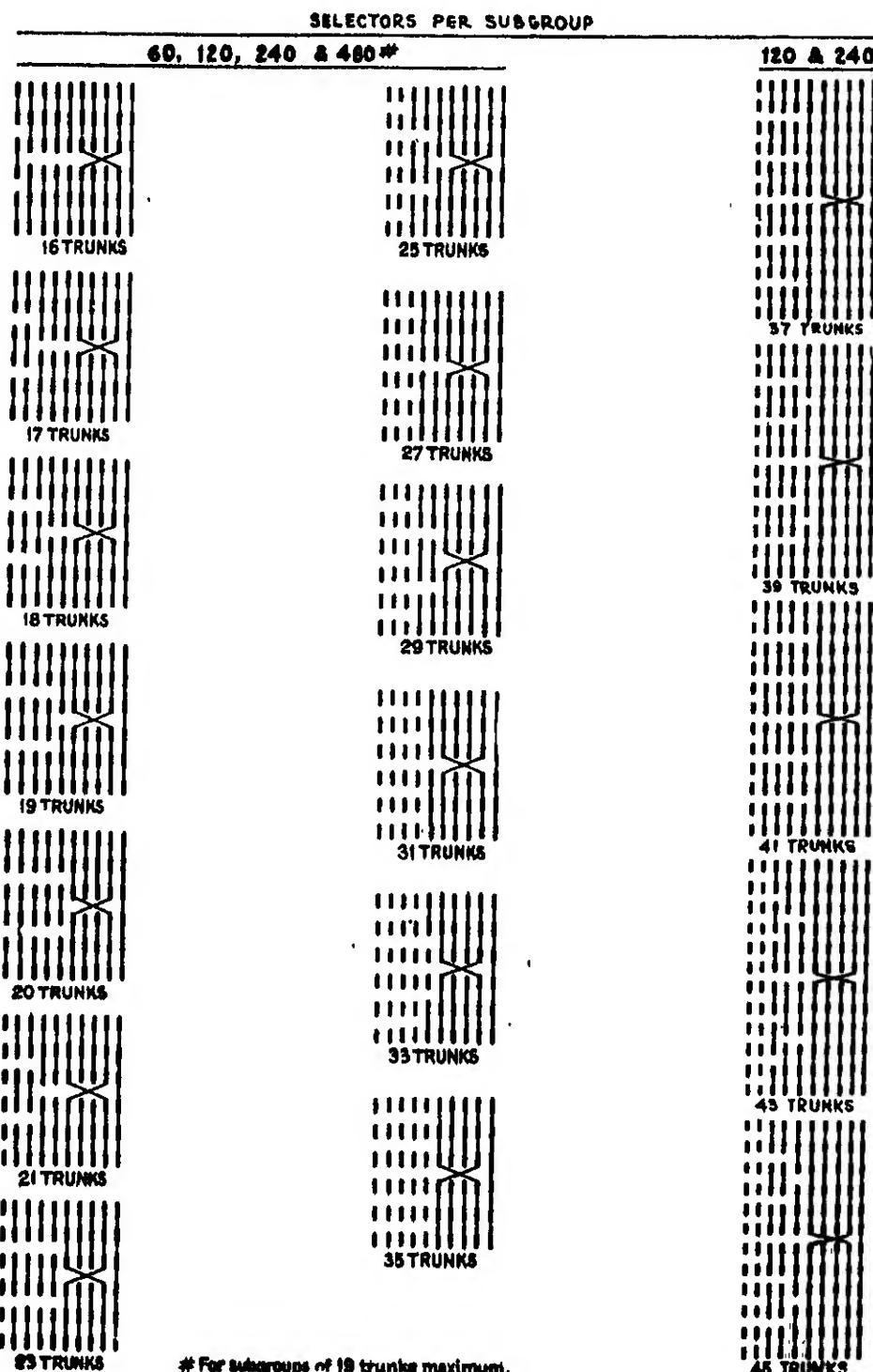


\* Plans for 20 selectors on 11 to 15 trunks inclusive are to be used for subgroups containing any multiple of 20 selectors. They are also used for irregular subgroups containing any number of selectors on 11-15 trunks, the reversal being placed approximately in the middle unless otherwise specified.

# For subgroups of 19 trunks maximum.

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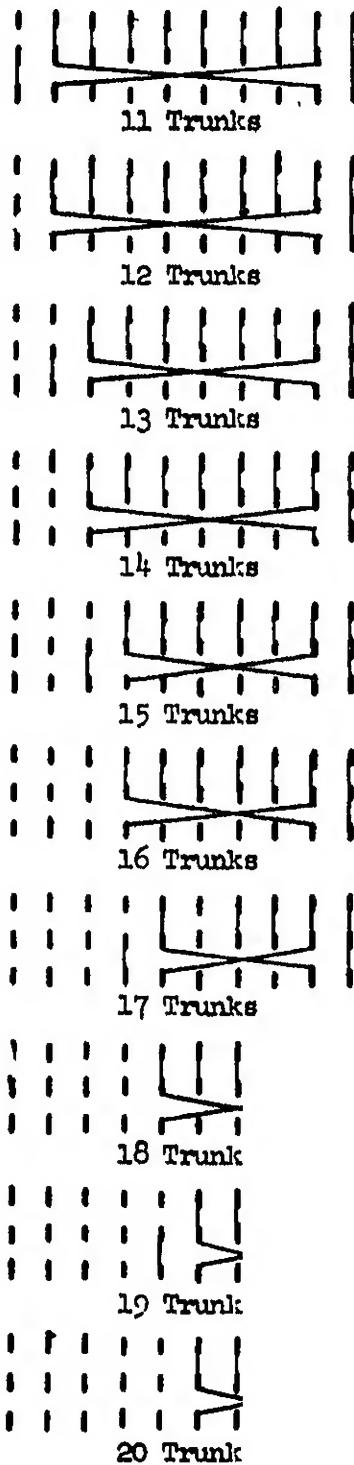
GRADED MULTIPLE ARRANGEMENTS  
FOR TRUNKS FROM SELECTOR MULTIPLE  
TO OTHER SELECTORS, TRUNKS OR REPEATERS



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FIGURE 1  
Page 2

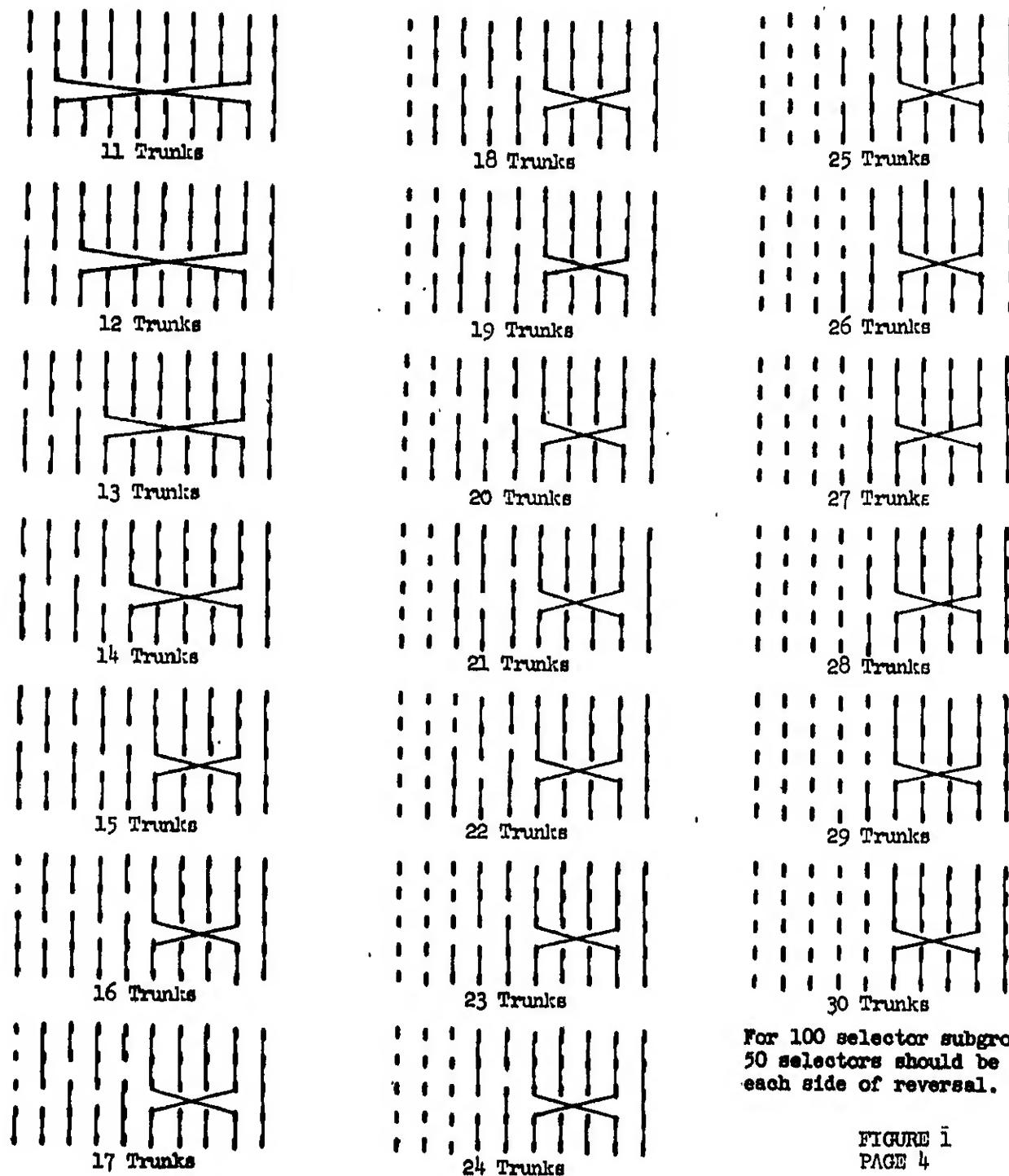
FORMS OF GRADED MULTIPLE FOR SELECTOR  
MULTIPLE TRUNKS TO SELECTORS, TRUNKS OR REPEATERS  
TO BE USED WITH SUBGROUPS OF 30 SELECTORS



## FORMS OF GRADED MULTIPLE FOR SELECTOR

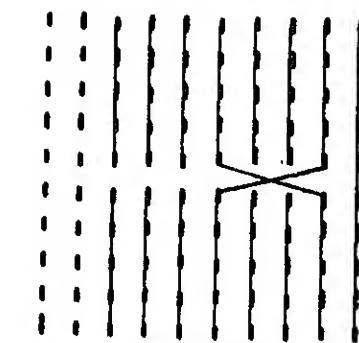
MULTIPLE TRUNKS TO SELECTORS, TRUNKS OR REPEATERS

TO BE USED WITH SUBGROUPS OF 50 AND 100 SELECTORS

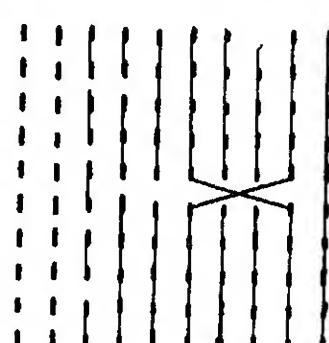


For 100 selector subgroup  
50 selectors should be on  
each side of reversal.

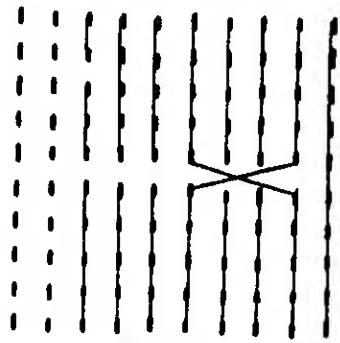
FORMS OF GRADED MULTIPLE FOR SELECTORS  
MULTIPLE TRUNKS TO SELECTORS, TRUNKS OR REPEATERS  
TO BE USED WITH SUBGROUPS OF 100 SELECTORS



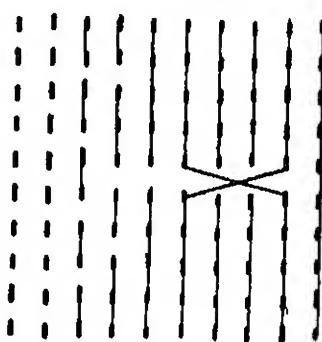
31 Trunks



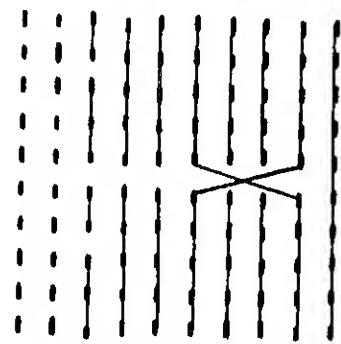
35 Trunks



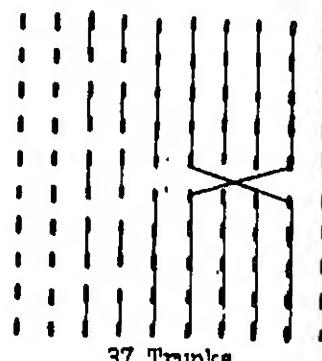
32 Trunks



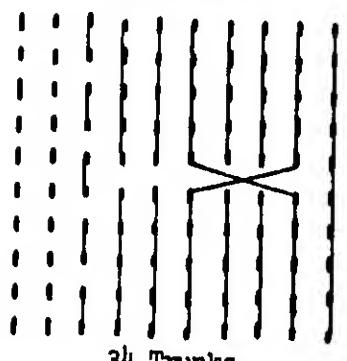
36 Trunks



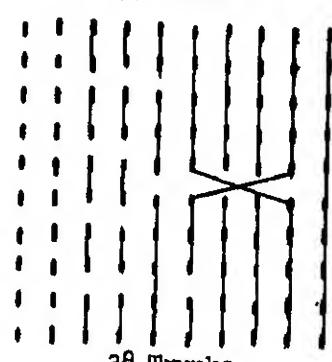
33 Trunks



37 Trunks



34 Trunks

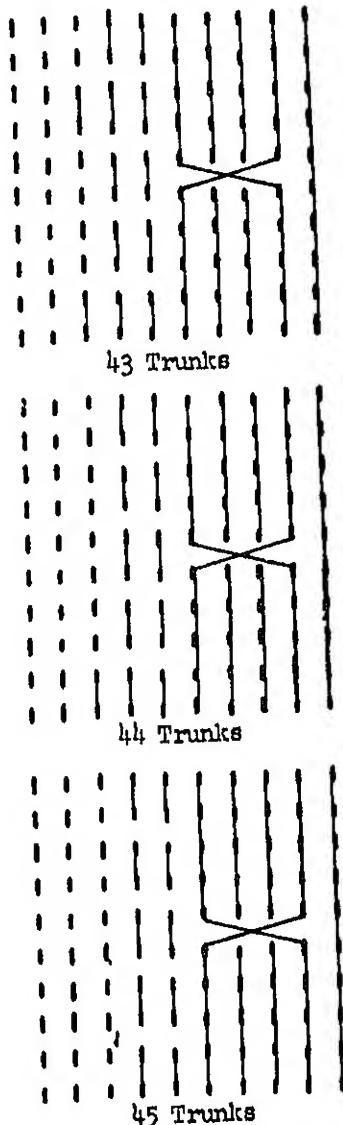
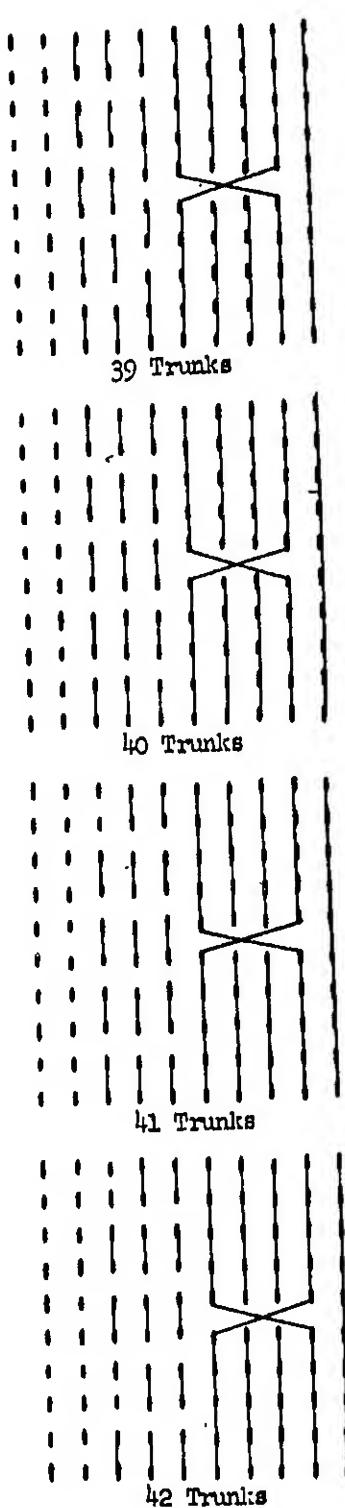


38 Trunks

FIGURE 1  
PAGE 5

## FORMS OF GRADED MULTIPLE FOR SELECTOR

MULTIPLE TRUNKS TO SELECTORS, TRUNKS OR REPEATERS  
TO BE USED WITH SUBGROUPS OF 100 SELECTORS



43 Trunks

44 Trunks

45 Trunks

40 Trunks

41 Trunks

42 Trunks

LINEFINDER AND CONNECTOR CAPACITY TABLES  
(In Unit Calls or CCS)

<u>Number of Switches</u>	<u>Linefinders 1.5% Delay*</u>	<u>Connectors (10 Terminal Access)</u>	
		<u>Table 10 P=.01</u>	<u>Table 30 P=.03</u>
3	20	16	24
4	37	30	42
5	55	46	62
6	77	64	83
7	98	84	105
8	122	105	129
9	144	126	153
10	168	149	178
11	192	168	199
12	218	187	220
13	242	205	242
14	270	223	262
15	296	241	284
16	324	259	305
17	352	276	327
18	380	294	347
19	408	312	367
20	436	329	387
21	462	347	406
22	494	364	425
23	520	382	444
24	550	399	463
25	580	417	483
26	610	433	503
27	640	451	523
28	670	468	542
29	700	485	562
30	730	502	602

\* 1.5 Percent Dial Tone Delay in Excess of 3 Seconds

**STEP-BY-STEP SELECTOR MULTIPLE TABLES**  
**10 TERMINAL ACCESS**

TABLE 1

TRUNKS	SELECTORS PER SUBGROUP																TRUNKS	
	320								240									
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP		
10	.33	106	.45	108	.69	110	.92	110	1.40	112	1.90	114	3.00	120	6.80	136	10	
11	.38	122	.52	124	.79	126	1.05	126	1.60	128	2.20	132	3.45	138	7.90	158	11	
12	.43	138	.58	140	.89	142	1.18	142	1.80	144	2.50	150	3.90	156	9.10	182	12	
13	.48	154	.65	156	.99	158	1.32	158	2.00	160	2.80	168	4.40	176	10.20	204	13	
14	.53	168	.71	170	1.08	172	1.45	174	2.20	176	3.07	184	4.85	194	11.40	228	14	
15	.57	182	.77	184	1.16	186	1.57	188	2.40	192	3.33	200	5.30	212	12.40	248	15	
16	.61	196	.83	198	1.25	200	1.70	204	2.60	208	3.60	216	5.75	230	13.30	266	16	
17	.66	210	.88	212	1.34	214	1.82	218	2.80	224	3.90	234	6.25	250	14.20	284	17	
18	.70	224	.94	226	1.43	228	1.95	234	3.00	240	4.20	252	6.75	270	15.00	300	18	
19	.74	238	1.01	242	1.53	244	2.08	250	3.23	258	4.50	270	7.30	292	15.70	314	19	
20	.78	252	1.07	256	1.61	258	2.22	266	3.43	274	4.80	288	7.85	314	-	-	20	
21	.83	266	1.13	270	1.71	274	2.35	282	3.63	290	5.10	306	8.35	334	-	-	21	
23	.92	294	1.24	298	1.90	304	2.60	312	4.05	324	5.70	342	9.40	376	-	-	23	
25	1.01	322	1.36	326	2.09	334	2.85	342	4.48	358	6.30	378	10.50	420	-	-	25	
27	1.09	348	1.48	354	2.28	364	3.10	372	4.90	392	6.97	418	-	-	-	-	27	
29	1.19	374	1.60	384	2.46	394	3.37	404	5.33	426	7.67	460	-	-	-	-	29	
31	1.26	402	1.72	412	2.65	424	3.65	438	5.78	462	8.34	500	-	-	-	-	31	
33	1.34	430	1.84	442	2.85	456	3.93	472	6.23	498	9.17	550	-	-	-	-	33	
35	1.44	460	1.97	472	3.05	488	4.21	505	6.69	535	9.75	585	-	-	-	-	35	
37	1.53	490	2.08	500	3.25	520	4.50	540	7.25	580	-	-	-	-	-	-	37	
39	1.63	520	2.21	530	3.47	555	4.79	575	7.81	625	-	-	-	-	-	-	39	
41	1.72	550	2.33	560	3.66	585	5.08	610	8.38	670	-	-	-	-	-	-	41	
43	1.81	580	2.46	590	3.84	615	5.38	645	8.88	710	-	-	-	-	-	-	43	
45	1.91	610	2.58	620	4.06	650	5.67	680	9.38	750	-	-	-	-	-	-	45	
	520	240	160	120	80	60	40	20										

## NON-GRADED GROUPS

TRUNKS	1	2	3	4	5	6	7	8	9
CCS CAPACITY	.1	1.6	6.9	15	27	40	55	71	88

STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 10

TRUNKS	SELECTORS PER SUBGROUP																TRUNKS	
	320		240		160		120		80		60		40		20			
	CCS CAPACITY PER																	
SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	
10	.47	149	.63	150	.95	152	1.28	154	1.95	156	2.63	158	4.10	164	9.10	182	10	
11	.52	168	.71	170	1.08	172	1.43	174	2.20	176	3.00	180	4.65	186	10.50	210	11	
12	.59	188	.79	190	1.20	192	1.62	194	2.47	198	3.37	202	5.25	210	11.90	238	12	
13	.65	208	.87	210	1.33	212	1.78	214	2.73	218	3.73	224	5.85	234	13.20	264	13	
14	.71	228	.96	230	1.45	232	1.95	234	2.98	238	4.10	246	6.45	258	14.50	290	14	
15	.77	246	1.03	248	1.56	250	2.12	254	3.23	258	4.33	266	7.00	280	15.80	316	15	
16	.82	264	1.11	266	1.68	268	2.27	272	3.48	278	4.77	286	7.60	304	17.10	342	16	
17	.88	282	1.18	284	1.80	288	2.43	292	3.73	298	5.13	308	8.20	328	18.20	364	17	
18	.94	300	1.26	304	1.91	306	2.60	312	3.98	318	5.50	330	8.80	352	19.20	384	18	
19	.99	318	1.34	322	2.03	324	2.77	332	4.25	340	5.90	354	9.45	370	20.20	404	19	
20	1.05	336	1.43	342	2.15	344	2.93	352	4.50	360	6.27	376	10.10	404	-	-	20	
21	1.11	354	1.50	360	2.27	364	3.08	370	4.77	382	6.63	398	10.75	430	-	-	21	
23	1.22	390	1.65	396	2.51	402	3.42	410	5.32	426	7.40	444	12.20	480	-	-	23	
25	1.33	426	1.80	432	2.74	438	3.75	450	5.88	470	8.17	490	13.25	530	-	-	25	
27	1.44	462	1.93	468	2.96	474	4.08	490	6.44	515	9.00	540	-	-	-	-	27	
29	1.56	498	2.10	505	3.19	510	4.42	530	7.00	560	9.92	595	-	-	-	-	29	
31	1.67	535	2.27	545	3.44	550	4.75	570	7.56	605	10.75	645	-	-	-	-	31	
33	1.78	570	2.44	585	3.69	590	5.13	613	8.12	650	11.58	693	-	-	-	-	33	
35	1.89	603	2.58	620	3.94	630	5.46	653	8.69	693	12.42	745	-	-	-	-	35	
37	2.02	643	2.73	655	4.22	673	5.79	695	9.31	745	-	-	-	-	-	-	37	
39	2.14	685	2.90	695	4.47	715	6.17	740	10.00	800	-	-	-	-	-	-	39	
41	2.25	720	3.04	730	4.72	755	6.54	783	10.63	850	-	-	-	-	-	-	41	
43	2.36	755	3.19	765	4.97	795	6.87	825	11.25	900	-	-	-	-	-	-	43	
45	2.48	795	3.33	805	5.25	840	7.23	870	11.87	950	-	-	-	-	-	-	45	
	320	240	160	120		80		60		40		20						

TRUNKS	1	2	3	4	5	6	7	8	9
	CCS CAPACITY	.4	3.4	16	30	76	64	84	105

FIGURE 4

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## STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 20

TRUNKS	SELECTORS PER SUBGROUP																TRUNKS	
	320		240		160		120		80		60		40		20			
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP		
10	.52	166	.70	168	1.06	170	1.42	170	2.18	174	2.93	176	4.55	182	10.10	202	10	
11	.58	186	.79	190	1.20	192	1.60	192	2.45	196	3.30	198	5.15	206	11.50	230	11	
12	.65	208	.88	212	1.34	214	1.78	214	2.73	218	3.70	222	5.80	232	12.90	258	12	
13	.72	230	.97	232	1.48	236	1.97	236	3.03	242	4.10	246	6.40	256	14.40	288	13	
14	.78	250	1.05	254	1.60	256	2.15	258	3.30	264	4.50	270	7.05	282	15.80	316	14	
15	.84	270	1.13	272	1.73	276	2.32	278	3.58	286	4.87	292	7.65	306	17.20	344	15	
16	.91	290	1.23	294	1.85	296	2.50	300	3.83	306	5.23	314	8.30	332	18.50	370	16	
17	.97	310	1.31	314	1.98	316	2.67	320	4.10	328	5.63	338	8.90	356	19.70	394	17	
18	1.03	330	1.39	334	2.10	336	2.85	342	4.38	350	6.04	362	9.55	382	20.80	416	18	
19	1.09	350	1.48	354	2.23	356	3.03	364	4.65	372	6.44	386	10.25	410	21.80	456	19	
20	1.16	370	1.56	376	2.36	378	3.22	386	4.93	394	6.67	410	10.95	438	-	-	20	
21	1.22	390	1.64	392	2.49	398	3.38	406	5.23	418	7.20	432	11.65	466	-	-	21	
23	1.34	430	1.81	434	2.74	438	3.75	450	5.80	464	8.04	482	13.00	520	-	-	23	
25	1.47	470	1.97	472	3.00	480	4.08	490	6.38	510	8.84	530	14.38	575	-	-	25	
27	1.59	510	2.13	510	3.25	520	4.46	535	6.94	555	9.75	585	-	-	-	-	27	
29	1.72	550	2.31	555	3.50	560	4.83	580	7.50	600	10.67	640	-	-	-	-	29	
31	1.84	590	2.48	595	3.78	605	5.21	625	8.13	650	11.50	690	-	-	-	-	31	
33	1.97	630	2.67	640	4.03	645	5.58	670	8.75	700	12.42	745	-	-	-	-	33	
35	2.09	670	2.83	680	4.31	690	5.96	715	9.44	755	13.34	800	-	-	-	-	35	
37	2.22	710	3.00	710	4.59	735	6.29	755	10.13	810	-	-	-	-	-	-	37	
39	2.34	750	3.17	760	4.88	780	6.67	800	10.81	865	-	-	-	-	-	-	39	
41	2.47	790	3.33	800	5.16	825	7.08	850	11.50	920	-	-	-	-	-	-	41	
43	2.59	830	3.50	835	5.44	870	7.46	895	12.13	970	-	-	-	-	-	-	43	
45	2.72	870	3.67	880	5.72	915	7.88	945	12.75	1020	-	-	-	-	-	-	45	
	320	240	160	120	80	60	40	20										
	NON-GRADING GROUPS																	
TRUNKS	1	2	3	4	5	6	7	8	9									
CCS CAPACITY	0.7	7.9	20	37	56	76	97	119	142									

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FIGURE 5

## STEP-BY-STEP SELECTOR MULTIPLE TABLES

10 TERMINAL ACCESS

TABLE 30

TRUNKS	SELECTORS PER SUBGROUP																TRUNKS	
	320		240		160		120		80		60		40		20			
	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP	SEL	GRP		
10	.56	178	.75	180	1.14	182	1.52	182	2.33	186	3.13	188	4.85	194	10.70	214	10	
11	.63	200	.84	202	1.28	204	1.72	206	2.60	208	3.53	212	5.50	220	12.10	242	11	
12	.69	222	.93	224	1.41	226	1.92	230	2.90	232	3.93	236	6.15	246	13.60	272	12	
13	.76	244	1.03	246	1.55	248	2.10	252	3.20	256	4.53	260	6.80	272	15.10	302	13	
14	.83	266	1.12	268	1.69	270	2.28	274	3.50	280	4.73	284	7.45	298	16.60	332	14	
15	.90	288	1.21	290	1.83	292	2.47	296	3.78	302	5.13	308	8.10	324	18.10	362	15	
16	.96	308	1.29	310	1.96	314	2.65	318	4.05	324	5.53	332	8.75	350	19.40	388	16	
17	1.03	328	1.38	332	2.09	334	2.83	340	4.35	348	5.94	356	9.40	376	20.60	412	17	
18	1.09	350	1.48	354	2.23	356	3.02	362	4.63	370	6.37	382	10.10	404	21.80	436	18	
19	1.16	370	1.57	376	2.36	378	3.20	384	4.93	394	6.80	408	10.80	432	22.80	456	19	
20	1.23	392	1.65	396	2.50	400	3.38	406	5.23	418	7.24	434	11.50	460	-	-	20	
21	1.29	412	1.73	416	2.64	422	3.57	428	5.53	442	7.67	460	12.20	488	-	-	21	
23	1.43	456	1.92	460	2.91	466	3.95	474	6.13	490	8.50	510	13.63	545	-	-	23	
25	1.56	500	2.08	500	3.19	510	4.33	520	6.75	540	9.34	560	15.00	600	-	-	25	
27	1.69	540	2.25	540	3.44	550	4.71	565	7.31	585	10.17	610	-	-	-	-	27	
29	1.81	580	2.44	585	3.69	590	5.08	610	7.94	635	11.09	665	-	-	-	-	29	
31	1.94	620	2.63	630	3.97	635	5.50	660	8.56	685	12.09	725	-	-	-	-	31	
33	2.06	660	2.81	675	4.23	680	5.92	710	9.19	735	13.09	785	-	-	-	-	33	
35	2.20	705	3.00	720	4.56	730	6.29	755	9.88	790	14.00	840	-	-	-	-	35	
37	2.34	750	3.17	760	4.88	780	6.67	800	10.56	845	-	-	-	-	-	-	37	
39	2.48	795	3.35	805	5.19	830	7.08	850	11.31	905	-	-	-	-	-	-	39	
41	2.61	835	3.52	845	5.47	875	7.50	900	12.00	960	-	-	-	-	-	-	41	
43	2.73	875	3.69	885	5.73	920	7.88	945	12.69	1015	-	-	-	-	-	-	43	
45	2.88	920	3.88	930	6.03	965	8.29	995	13.38	1070	-	-	-	-	-	-	45	
	320	240	160	120		80		60		40		20						

TRUNKS	1	2	3	4	5	6	7	8	9
	0CB CAPACITY	1.1	9.7	24	42	62	83	105	129

STEP-BY-STEP SELECTOR GRADED MULTIPLE TABLES

10 Terminal Access

Unit Calls Per Selector and Subgroup Capacity

Trunks Per Subgrp.	Table 10 (P = .01)						Table 20 (P = .02)						Table 30 (P = .03)						Trunks Per Subgrp.
	100	Sel. S-G	50	Sel. S-G	30	Sel. S-G	100	Sel. S-G	50	Sel. S-G	30	Sel. S-G	100	Sel. S-G	50	Sel. S-G	30	Sel. S-G	
10	1.54	154	3.19	159	5.63	169	1.72	172	3.58	179	6.23	187	1.84	184	3.80	190	6.64	199	10
11	1.74	174	3.64	182	6.49	195	1.93	193	4.03	201	7.13	213	2.09	209	4.30	215	7.57	227	11
12	1.94	194	4.08	204	7.36	221	2.14	214	4.51	225	8.04	241	2.31	231	4.80	240	8.51	255	12
13	2.14	214	4.52	226	8.23	247	2.35	235	4.99	249	8.95	269	2.53	253	5.30	265	9.45	284	13
14	2.34	234	4.96	248	9.10	276	2.56	256	5.47	274	9.87	296	2.75	275	5.80	290	10.40	312	14
15	2.54	254	5.40	270	9.97	299	2.77	277	5.95	298	10.79	324	2.97	297	6.30	315	11.35	341	15
16	2.74	274	5.84	292	10.83	325	2.98	298	6.43	322	11.71	351	3.20	320	6.80	340	12.30	369	16
17	2.94	294	6.29	315	11.69	351	3.19	319	6.91	346	12.63	379	3.43	343	7.30	365	13.25	398	17
18	3.13	313	6.74	337	12.54	376	3.41	341	7.39	370	13.55	407	3.66	366	7.80	390	14.20	426	18
19	3.33	333	7.22	361	13.39	402	3.63	363	7.88	394	14.47	434	3.89	389	8.30	415	15.14	454	19
20	3.53	353	7.70	385	14.24	427	3.85	385	8.38	419	15.39	462	4.12	412	8.82	441	16.07	482	
21	3.73	373	8.18	409	4.07	407	8.89	445	4.34	434	9.35	468							
22	3.93	393	8.66	433	4.29	429	9.41	471	4.56	456	9.89	495							
23	4.13	413	9.15	458	4.51	451	9.94	497	4.79	479	10.43	524	5.02	502	10.98	549			
24	4.34	434	9.65	483	4.73	473	10.47	524	5.25	525	11.54	577	5.48	548	12.10	605			
25	4.54	454	10.16	508	4.96	496	11.01	551	5.78	578	12.10	605	5.71	571	12.67	634			
26	4.74	474	10.68	534	5.19	519	11.55	578	5.42	542	12.10	605	5.94	594	13.25	662			
27	4.94	494	11.20	560	5.42	542	12.10	605	5.65	565	12.65	633	6.17	617	13.81	691			
28	5.14	514	11.72	586	5.88	588	13.20	660	6.11	611	13.75	687	6.40	640	14.37	719			
29	5.34	534	12.24	612	6.34	634	13.75	687	6.57	657	14.37	719	6.63	663	14.87	747			
30	5.55	555	12.75	637	6.80	680	14.87	747	7.03	703	15.37	787	7.11	711	15.87	811			
31	5.76	576			7.26	726	16.37	803	7.49	749	17.37	843	7.61	761	17.87	877			
32	5.98	598			7.57	657	17.87	877	7.73	773	18.37	913	8.13	813	18.87	943			
33	6.20	620			8.00	680	18.37	913	7.98	798	19.37	943	8.40	840	19.87	973			
34	6.42	642			8.34	634	19.37	943	8.23	823	20.37	973	8.67	867	20.87	1003			
35	6.65	665			8.76	726	20.37	973	9.00	890	21.37	1003	9.37	937	21.87	1033			
36	6.88	688			9.19	749	21.37	1003	9.34	898	22.37	1033	9.72	972	22.87	1063			
37	7.11	711			9.62	773	22.37	1033	9.88	908	23.37	1063	10.19	1019	23.87	1103			
38	7.35	735			10.05	803	23.37	1063	10.24	924	24.37	1103	10.67	1067	24.87	1143			
39	7.69	769			10.48	843	24.37	1103	10.49	949	25.37	1143	11.04	1104	25.87	1183			
40	7.83	783			10.91	873	25.37	1143	10.95	975	26.37	1183	11.51	1151	26.87	1223			
41	8.07	807			11.34	908	26.37	1223	11.34	934	27.37	1263	12.04	1204	27.87	1303			
42	8.31	831			11.77	949	27.37	1263	11.77	977	28.37	1303	12.61	1261	28.87	1363			
43	8.55	855			12.20	988	28.37	1303	12.20	1010	29.37	1403	12.81	1281	29.87	1443			
44	8.78	878			12.63	1010	29.37	1403	12.63	1043	30.37	1443	13.21	1321	30.87	1503			
45	9.01	901			13.06	1043	30.37	1443	13.06	1073	31.37	1503	13.61	1361	31.87	1563			

REA-TE & CM-520

## EXAMPLE

Note Describing Office Used in Example  
Diamond 2 Office (342)

The office used as an example is designed to accommodate 1,177 working lines and 2,306 working terminals. A 2-5 numbering plan is used and the equipment is arranged to permit the completion of intraoffice calls by dialing the five numerals of the listed number, or if all seven digits are dialed the calls will also be completed. Only the last four digits will be effective on local intraoffice calls. The full seven digits as listed in the directory are to be dialed on calls to the two EAS offices. The central office is to be covered by a maintenance man several hours each day.

It is assumed that this office is a tributary of a toll center located in another town. If this office were a toll center toll dial equipment and the toll switchboard would have to be provided but these would be completely separate and distinct from the local dial equipment. Refer to Sections 511 and 512 of the TE & CM for details of these toll facilities.

The fundamental traffic information is developed as shown in Appendix 1 and the amounts and arrangement of the equipment as determined from the fundamental data is shown in Appendix 2. A trunking schematic is included as Appendix 3.

EXAMPLE

Fundamental Traffic Data  
DIamond 2 Office (342)

<u>Class of Service</u>	<u>Stations</u>		<u>Lines</u>	
	<u>Present</u>	<u>End 5 Year Period</u>	<u>Present</u>	<u>End 5 Year Period</u>
Business 1-Party	172	200	172	200
Business 2-Party	37	43	25	23
Business 4-Party	11	15	5	5
Coin Postpay	7	12	7	12
Residence 1-Party	298	373	298	373
Residence 2-Party	502	627	330	348
Residence 4-Party	258	322	93	90
PBX and Associated (Flat Rate)*	24	31	24	31
Rural	<u>293</u>	<u>683</u>	<u>38</u>	<u>95</u>
Total Main Stations	1,602	2,306	992	1,177
PBX and Associated (Flat Rate)	178	207		
Extensions	<u>63</u>	<u>82</u>		
Total Stations	1,843	2,595		

\*Includes two and three line key sets. Maximum number of trunks in any PBX group is 10.

EXAMPLE

Fundamental Traffic Data  
Diamond 2 Office (342)

Lines, Main Stations and Estimated Originating Busy Hour Traffic

<u>Class of Service</u>	<u>Main Stations</u>	<u>Lines</u>	<u>Unit Calls Per Line</u>	<u>Unit Calls</u>
Flat Rate, PBX and Coin	2,306	1,177	1.79	2,105

Connector Terminal Requirements

Number of Connector Groups

Assume 24 connector groups for the 2,306 main stations.

Average working terminals per group  $2,306 \div 24 = 96$ .

Provide 1 rotary hunting and 23 regular groups.

Regular Connector Terminals

Total Main Stations  $23 \times 97 = 2,231$   
(including rural, excludes coin)

Rotary Hunting Connector Terminals

PBX and Associated Lines	31
Postpay Coin	12
Individual Lines	<u>32</u>
Total	75

2

Appendix 1  
TE & CM-520

EXAMPLE

Fundamental Traffic Data  
DIamond 2 Office (342)

Terminating Unit Calls at Connectors

Type of Connector Groups	Working Terminal Per Group	U.C. Per Terminal	Number Groups	Total U.C.
Regular	97	.90	23	2,008
PBX & Associated (See Note)	31	3.65		113
Rotary Hunting Individual	32	1.00	1	32
Coin	12	.483		7
				2,160

NOTE: The PBX and Associated Lines made up of 9 groups of 2 trunks each, 3 groups of 3 trunks each and 1 group of 4 trunks.

Assignment of Connector Groups

Thousand Groups	Second Selector Levels									
	1	2	3	4	5	6	7	8	9	0
4000	R	R	R	R	-	-	-	-	-	R = Regular
3000	R	R	R	R	R	R	R	R	R	RH = Rotary Hunting
2000	R	R	R	RH	R	R	R	R	R	

EXAMPLE

Fundamental Traffic Data  
Diamond 2 Office (342)

Distribution of Unit Calls from First Selector Levels

Diamond (342) Office

<u>Level</u>		<u>Traffic From</u>		
		<u>Subscribers</u>	<u>1st. Selectors</u>	<u>EAS</u>
	0 Special Service and CLR		152	
(B)	9 Multiple to Level 2			
	8 EAS - Code 658		145	
	7 EAS - Code 357		78	
(AR)	6 Reserved			
(A)	5 Reserved			
(AR)	4 Second Selectors		273	41 35
(AR)	3 Second Selectors		681	104 88
(A)	2 Second Selectors		733	111 94
	1 Service Code Selectors		53	6

Traffic To and From EAS Offices

<u>Office</u>	<u>Number of Trunks</u>	<u>Unit Calls</u>		
		<u>Outgoing</u>	<u>Incoming</u>	<u>Total</u>
658	15 (1 and 2-Way)	145	170	315
357	10 (2-Way)	78	92	170
Toll	9 Outgoing and 13 Incoming	152	217	369

EXAMPLE

Fundamental Traffic Data  
DIamond 2 Office (342)

Second Selector Multiple Traffic to Connectors-2,000 Group\*

<u>Group</u>	<u>To</u>	<u>Unit Calls</u>
2,000	Regular	87
2,900	Regular	87
2,800	Regular	87
2,700	Regular	87
2,600	Regular	87
2,500	Regular	87
2,400	Rotary Hunting	152
2,300	Regular	87
2,200	Regular	87
2,100	Regular	87

\*The 3,000 and 4,000 groups of second selectors will have all working levels assigned to regular connector groups with 87 unit calls per connector group.

Distribution of U.C. from Levels of Service Code Selectors

<u>Level</u>	<u>To</u>	<u>Unit Calls</u>
0		
9	Reverting (119)	27
8	Dial and Ringer Test (118)	1 (P = .03)
7	Test Desk (117)	5
6	Vacant	
5	Vacant	
4	Repair Service (114)	10
3	Information (113)	21
2	Vacant	
1	Vacant	

EXAMPLE

Determination of Switch Quantities  
Diamond 2 Office (342)

Line Finders

Flat Rate, PBX and Coin Lines = 1.79 U.C. Per Line

Working Lines per Group  $198 \times 1.79 = 354$  U.C. per Group

From Line Finder Table 1.5% D.T. Delay 18 L.F. per Group

$1,177$  Lines  $\div 198 = 5$  Full Groups  $+ 187$  Lines

$187 \times 1.79 = 335$  U.C. in Partial Group

From Line Finder Table 17 L.F. for Partial Group

Total Line Finders  $5 \times 18 + 17 = 107$

Rather than provide the linefinder grouping as determined above with one partial group it was found more economical and desirable from an equipment layout standpoint to specify six fully equipped linefinder groups as follows:

Working Lines per Group  $196 \times 1.79 = 351$  U.C. per Group  
or 17 Line Finders per Group.

<u>Class</u>	<u>No. of Groups</u>	<u>Working Lines Per Group</u>	<u>Linefinders Per Group</u>	<u>Total Linefinders</u>
FR, PBX & Coin	6	196	17	102

First Selectors

Subscriber 1st Selectors, FR, PBX

EAS Incoming 1st Selectors from 65  
2-Way (See 1st Selector Level 8)

EAS Incoming 1st Selectors from 35

Toll Incoming 1st Selectors, 1-Way

### EXAMPLE

Determination of Switch Quantities  
Diamond 2 Office (342)

### First Selector Multiple

Level 0 To CLR Operator  $\times$  152 U.C. ( $P = .03$ ) or 9 Trunks.

NOTE: Outgoing access to five 1-way out and five 2-way trunks. Number of these trunks determined from graded multiple table in Section 510.

Level 7 To and from Elgin 7 (357) EAS, 78 outgoing  
+ 92 incoming U.C., total 170 (P = .05) = 10 Trunks.

#### Level 4 To 2nd Selectors ( $P = .02$ )

For the 15 shelves of first selectors assume that they are equivalent to 16 shelves or 160 selectors in selecting a grading pattern. Total traffic for the level, 349 U.C. and from the table (Figure 5) for the 160 selector subgrouping = 19 Trunks. No modification of grade was made but the traffic and arrangement of selectors is as follows:

<u>Class</u>	<u>Number</u>	<u>Number</u>		<u>% of</u>	<u>Theoretical</u>
<u>Selectors</u>	<u>Shelves</u>	<u>Selectors</u>	<u>U.C.</u>	<u>Total</u>	<u>Number of</u>
				<u>U.C.</u>	<u>Individual</u>
Subscriber	3	30	80.4	23	3.2
Subscriber	3	30	80.4	23	3.2
Subscriber	5	42	112.5	32	4.5
EAS & Toll	4	33	76.0	22	3.1

### Individual Trunks 14

**Total Second Selectors, Level 4**

EXAMPLE

Determination of Switch Quantities  
Diamond 2 Office (342)

Level 3 To 2nd Selectors ( $P = .02$ )

Subscriber 1st Selector Traffic 681 U.C.

Unit Calls delivered by each selector,  $681 \div 102 = 6.67$

From the table (Figure 5) for 80 selectors = 27 Trunks

Remaining traffic,  $22 \times 6.67 = 147$  U.C.

From EAS, 20 Selectors = 104

From Toll, 13 Selectors = 88

Total 339 U.C.

Above shelf arrangement for the second group of 55 selectors assume to be equivalent to six shelves.

From the table (Figure 5) for 60 selectors = 18 Trunks

The modified grading pattern for this group determined as follows:

Class Selectors	Shelf Number	Number Selectors	U.C.	% of Total U.C.	Theoretical Number of Individual Trunks	Grading Pattern
Subscriber	9	10	66.7	39.5	5	
Subscriber	10	10	66.7			
Subscriber	11	2	13.4	29.8	4.0	
Toll	12	3	20.3			
Toll	13	10	67.7	30.7	4.0	
EAS	14	10	52.0			
EAS	15	10	52.0	30.7	4.0	

Individual Trunks 13

Total Second Selectors, Level 3, 27 + 18 = 45

**EXAMPLE**

## Determination of Switch Quantities Diamond 2 Office (342)

### Level 2 To 2nd Selectors ( $P \approx .02$ )

Subscriber 1st Selector Traffic 733 U.C.

Unit Calls delivered by each selector  $733 + 102 = 7.19$

From the table (Figure 5) for 80 selectors  $\approx$  29 Trunks

Remaining traffic,  $22 \times 7.19 = 158$

From EAS, 20 Selectors ■ 111

From Toll. 13 Selectors 94

363 U.C.

Above shelf arrangement for the second group of 55 selectors assume to be equivalent to 6 shelves.

From the table (Figure 5) for 60 selectors and 363 Unit Calls = 19 Trunks.

The modified grading pattern for this group determined as follows:

### Individual Trunks 14

Total Second Selectors, Level 2: 29 + 19 = 48

EXAMPLE

Determination of Switch Quantities  
DIamond 2 Office (342)

Level 1 To Service Code Selectors ( $P = .01$ )  
Adding the Traffic  $53 + 6 = 59$  U.C. ..... 6 Trunks

Trunks from Service Code Selectors

Code 119 Revertive Call Switches  
27 Unit Calls ( $P = .01$ ) = 4

Code 114 Repair Service

Code 113 Information

A combined group of trunks to the operating center will be used for the 114 and 113 traffic as well as for intercepting.

The 21 Information U. C. + 10 Repair + 13 Intercepting = 44 U.C.  
( $P = .03$ ) = 5 Trunks

NOTE: In this case it is assumed that cable pairs are available for this separate group, otherwise this traffic would have been combined with the Assistance and CLR over the "0" channel.

Second Selector Multiple to Connectors

To each of the 23 regular connector groups the  $87 +$  unit calls will require 8 connectors ( $P = .01$  or Table 10, Figure 2)

The one rotary hunting connector group with 152 unit calls will require 11 connectors.

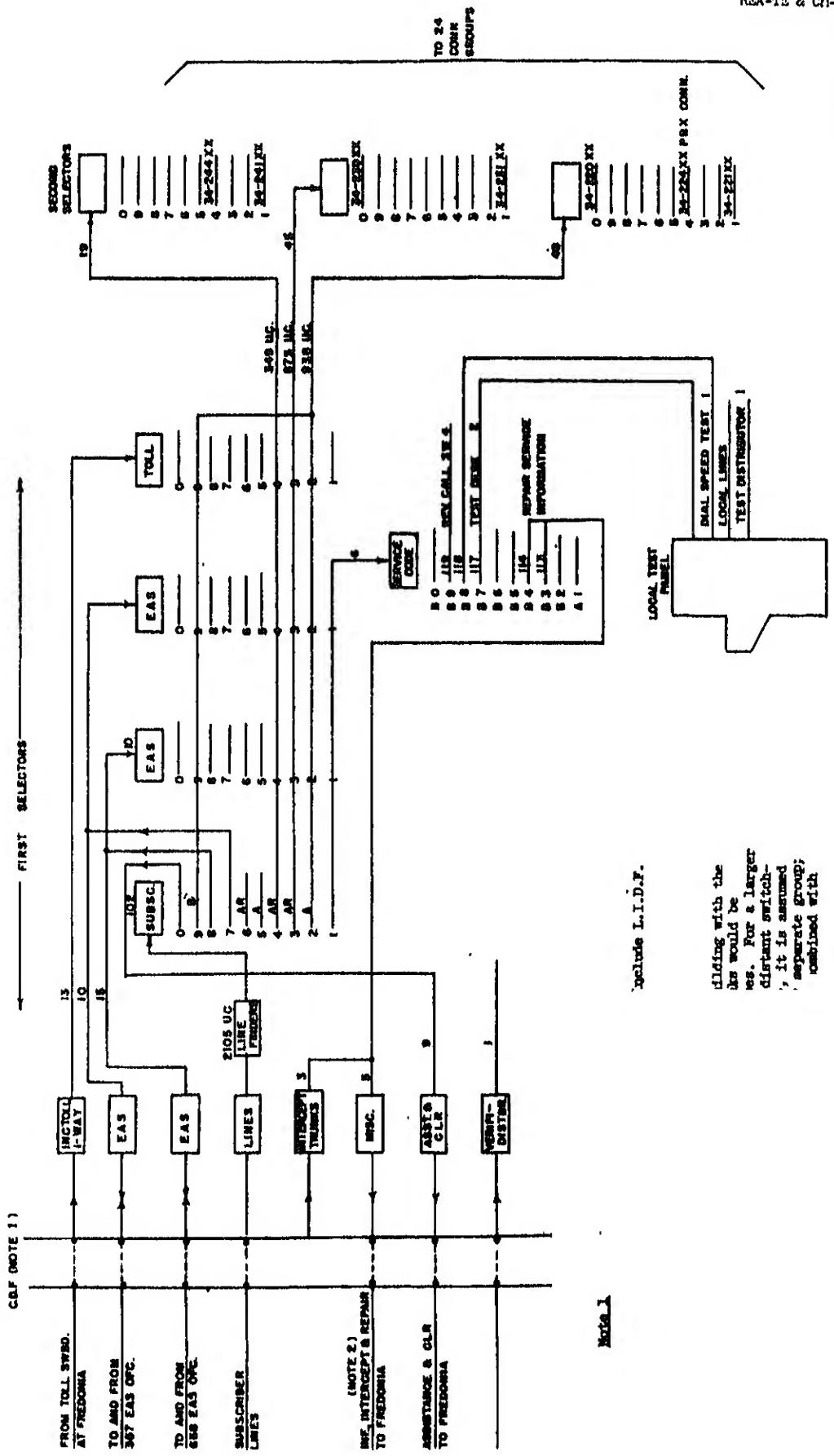
Total Connectors:

23 regular groups of 8 = 184  
1 rotary hunting group = 11  
test connectors = 24 (1 per group)

Intercepting Equipment

Number intercepting lines, regular groups =	<u>23</u>
Number intercepting lines, rotary group =	<u>2</u>
Number trouble intercepting lines =	<u>3</u>
Number vacant selector level intercepting lines =	<u>2</u>
Total Intercepting Lines	<u>30</u>
Number intercept concentrating switches	<u>3</u>

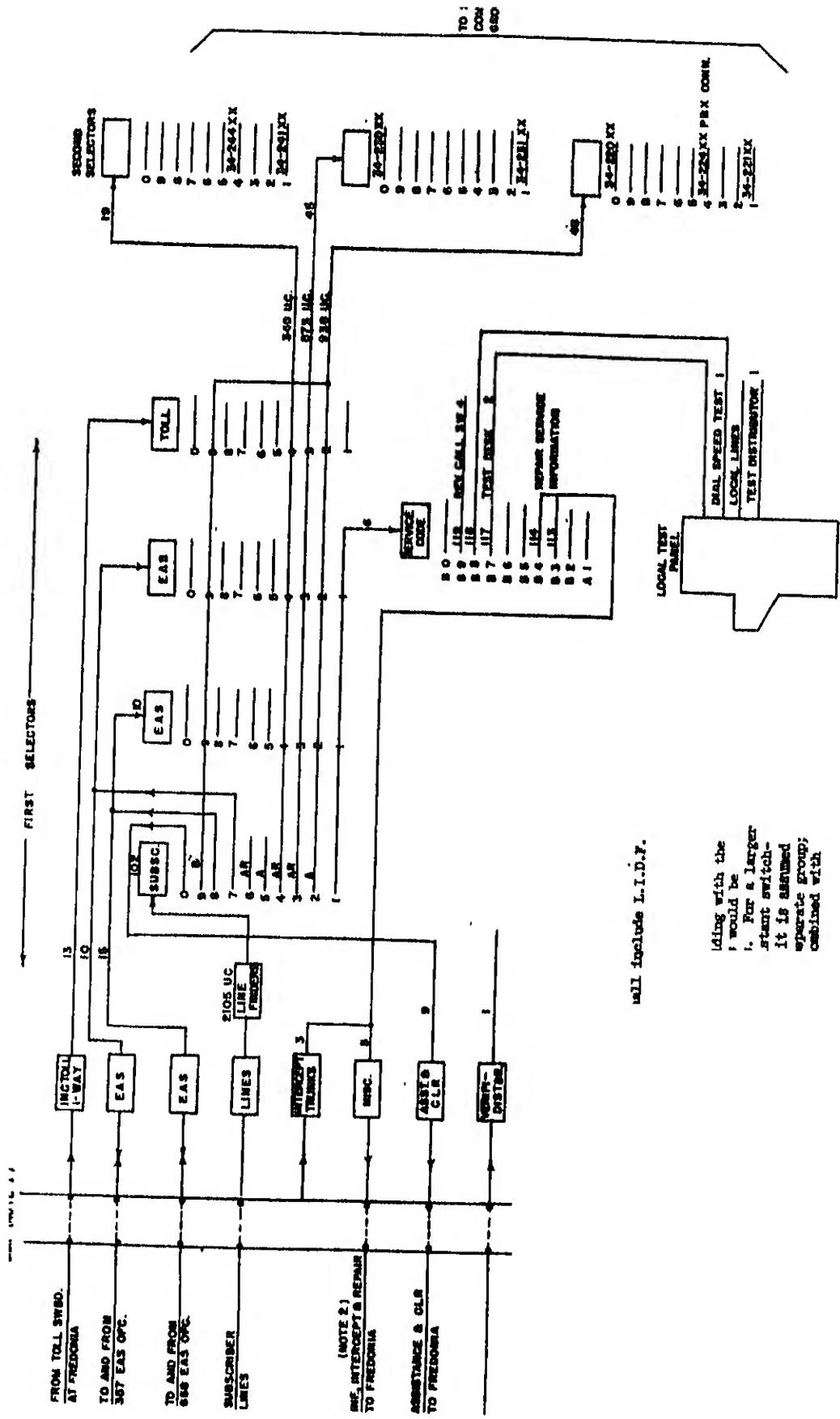




ABC TELEPHONE COMPANY  
WHITE RIVER, TEXAS  
TEXAS 000  
TRUNKING SCHEMATIC  
DIAMOND 2 OFFICE (342)

### Appendix 3 Example - Trunking Schematic





ABC TELEPHONE COMPANY  
WHITE RIVER, TEXAS  
TEXAS 000  
TRUNKING SCHEMATIC  
DIAMOND 2 OFFICE (342)

will include L.I.D.Y.

lding with the  
s would be  
s. For a larger  
stant switch-  
it is assumed  
separate group;  
combined with

Appendix 3 Example - Training Schematic